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(54) Separation of components of mixtures

(57) In apparatus for and a method of separating the components of a mixture, the mixture is admitted to a first inlet (30) which communicates with a working region which may be defined by a cylindrical tube (12). A fluid under pressure is admitted to a second inlet (9) which also communicates with the working region. The fluid forms a spiralling flow which draws the mixture into the working region in the form of a vortex. In the working region, the energy of the spiralling fluid vaporises at least one of the components of the mixture, ready for the vaporised component to be separated from the remainder of the mixture. In the apparatus, the second inlet (9) communicates with the working region via a chamber (34) and a throat which may be defined between the inlet (30) and the working tube (12), and the mixture is conveyed from the working region along an outlet (18).

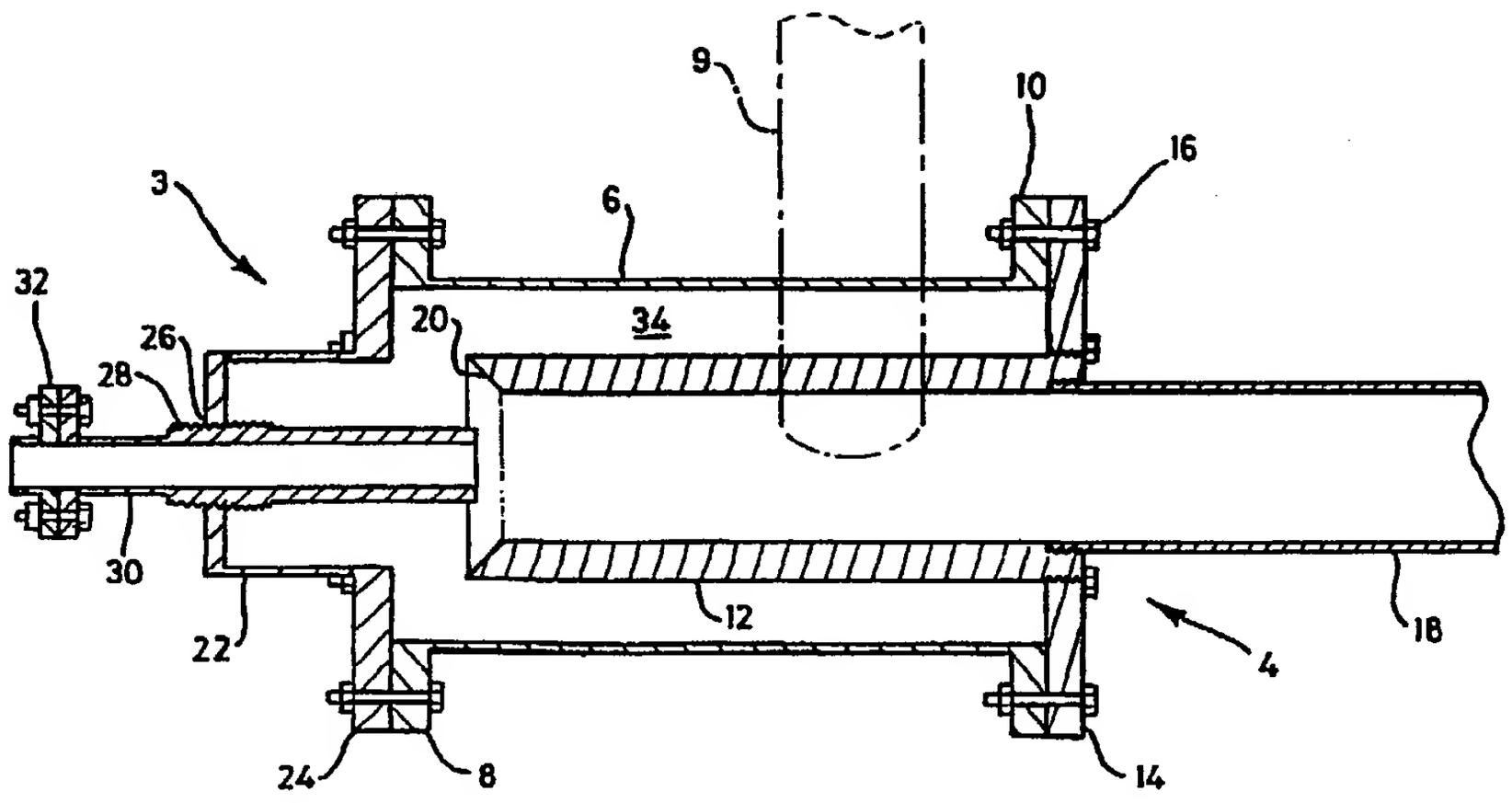

Fig. 2

GB 2 268 418 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

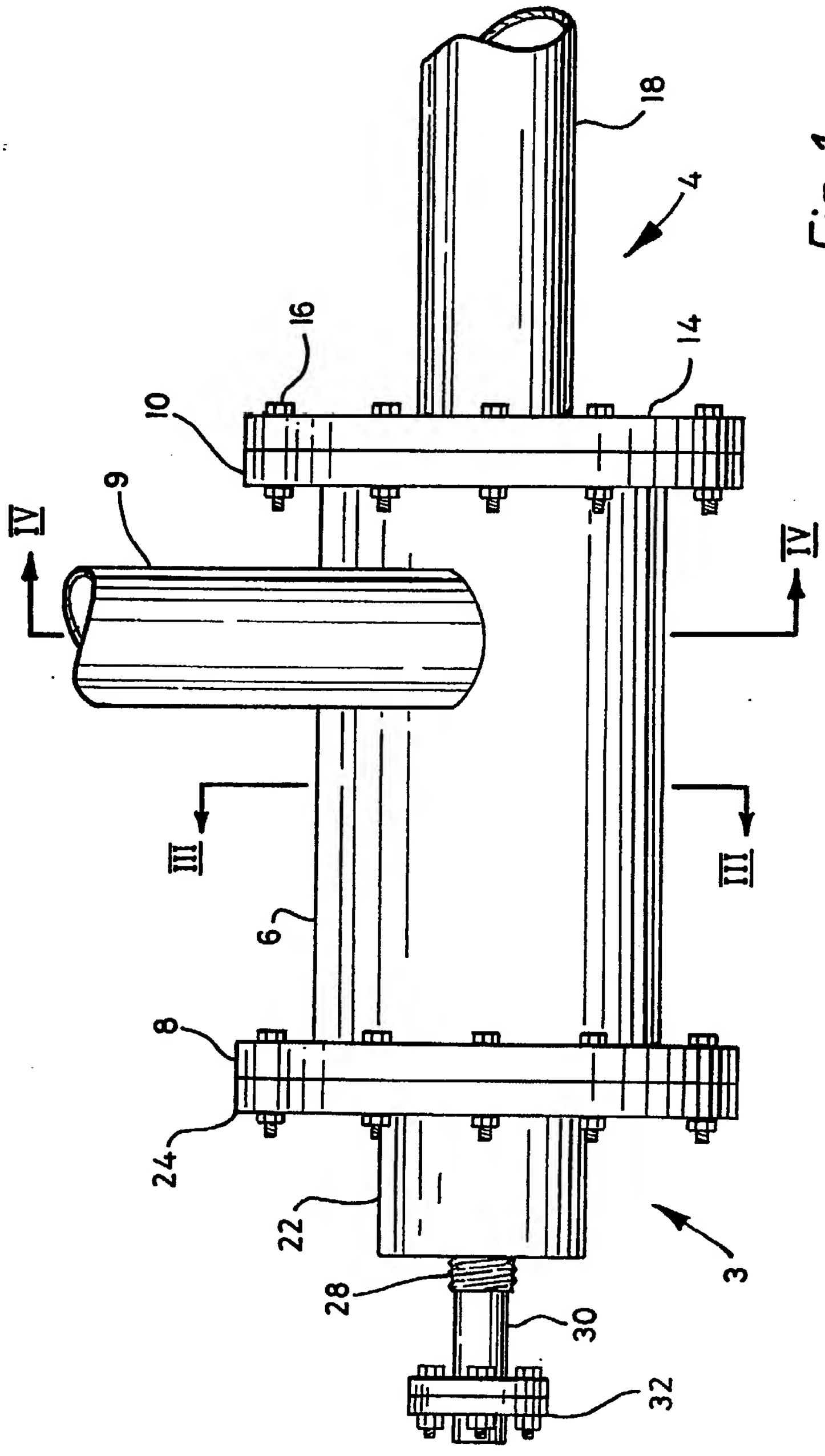

Fig. 1

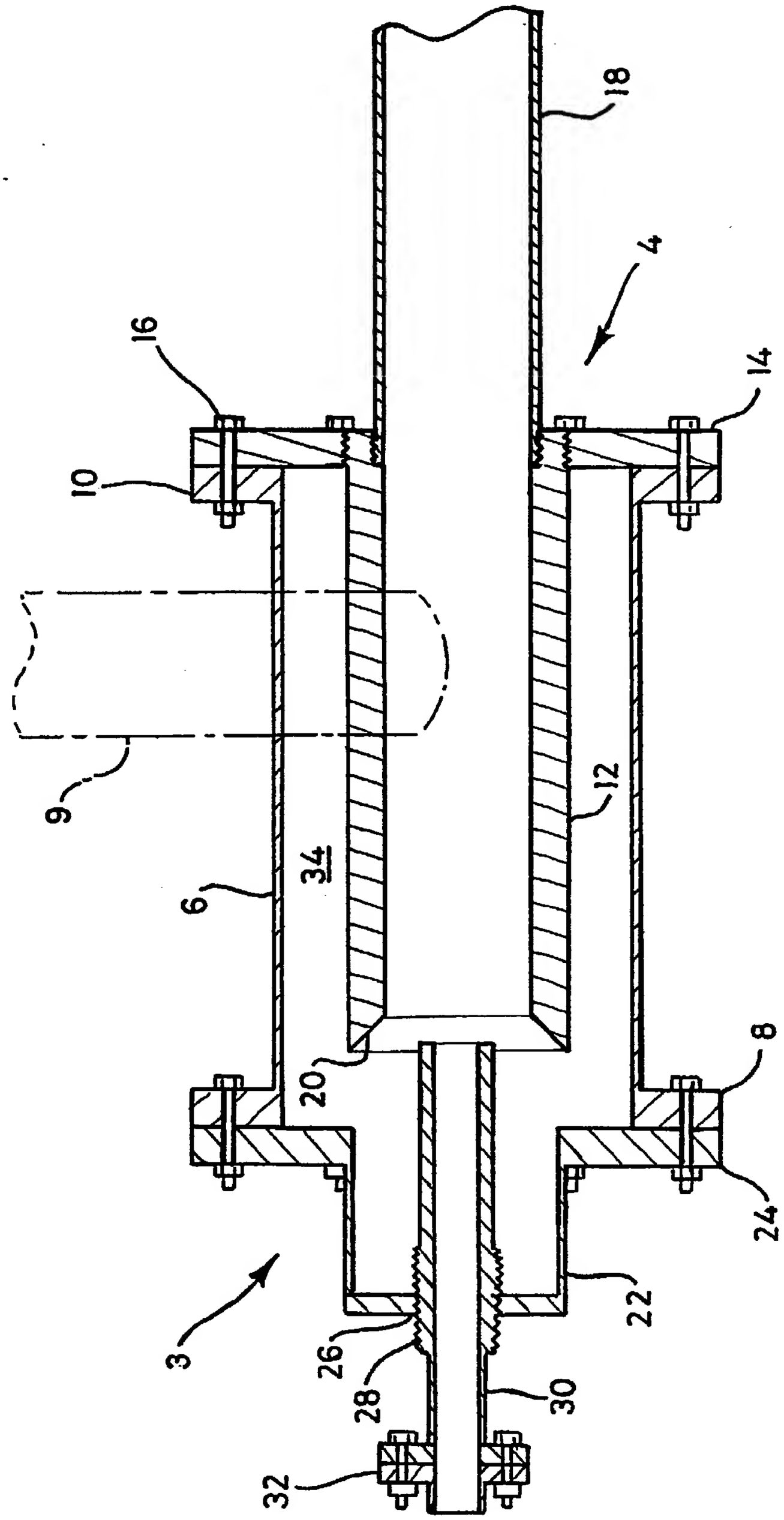

Fig. 2

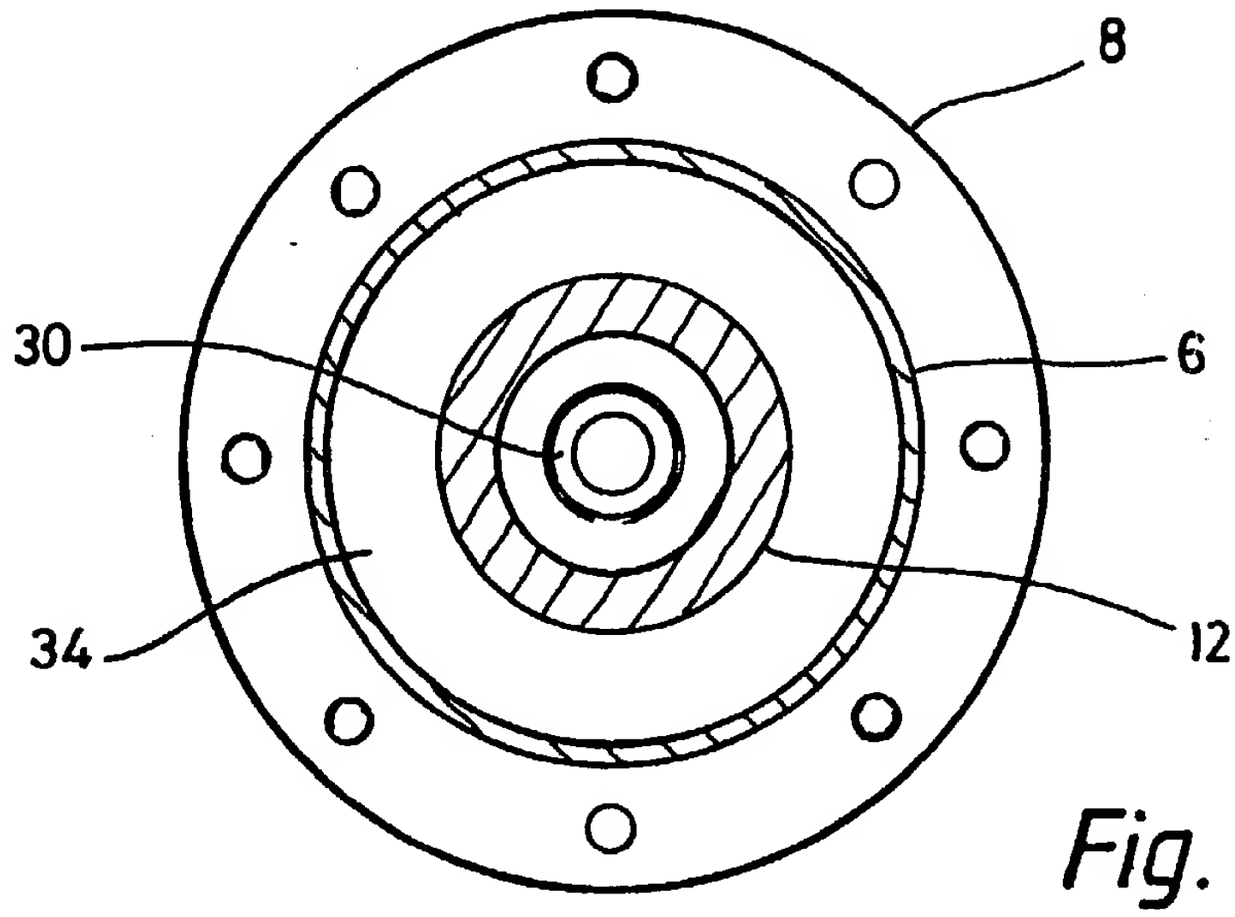

Fig. 3

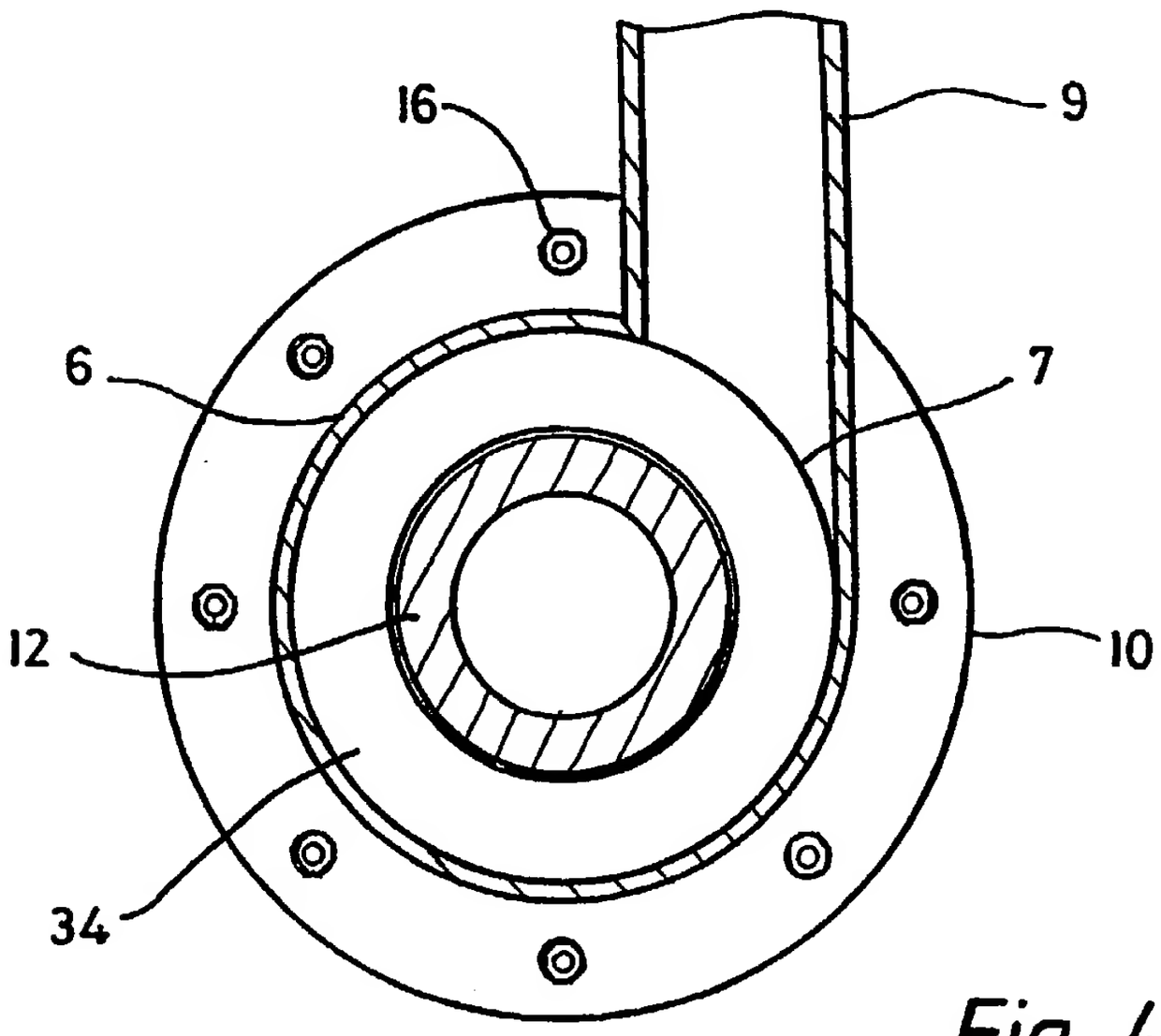

Fig. 4

Title: Separation of Components of Mixtures

Field of the Invention

This invention relates to an apparatus and method of separating the components of a mixture, for example in the de-watering of slurries such as sewage or coal slurries.

Background to the Invention

Conventional methods of removing water from slurries generally consume large amounts of energy. For example, one known method involves the application of large quantities of heat in order to vaporise the water from the slurry. The invention aims to provide a simpler and more efficient apparatus and method.

Disclosure of the Invention

According to one aspect of the invention apparatus for separating the components of a mixture comprises a first inlet to admit the mixture, a second inlet to admit a fluid under pressure, an outlet for the components of the mixture and a chamber into which the second inlet leads and which is shaped in relation to the second inlet such that the admitted fluid forms a spiralling flow, the downstream end of the first inlet communicating with a working region of the apparatus, the working region communicating with the chamber by means of a throat

through which the spiralling fluid, in the form of a vortex, is drawn into the working region, in the working region the energy of the spiralling fluid vaporising at least one of the components of the mixture which passes through the outlet ready for the vaporised component to be separated.

The vaporised component may be separated from the remainder of the mixture by any convenient known means, such as a cyclone separator. In its normal application for the de-watering of slurries, the mixture has a solid component which is the desired component, but it will be appreciated that the vaporised component may be readily condensed and recovered if it is the desired component.

The working region is preferably defined within a working tube, conveniently cylindrical, which may define the inner periphery of the chamber, the outer periphery of which is defined by an outer casing such as a sleeve, the chamber thus being annular and surrounding the working region to provide a compact arrangement.

The throat is preferably defined between the downstream end of the first inlet and one end of the working tube, said one end preferably being bevelled so as to provide, between the bevelled end of the tube and the first inlet, a throat of progressively decreasing cross-sectional area in the direction of travel of the fluid as it enters the working region.

In a preferred arrangement the first inlet is a cylindrical tube which is co-axial with the working tube which is of larger diameter than the tube forming the first inlet, the latter conveniently being adjustable in

an axial direction to vary the effective width of the throat and, therefore, the extent of suction in the working region when the apparatus is in use.

The fluid is preferably gaseous, conveniently air, and the second inlet conveniently enters the chamber in a tangential direction so as to promote the desired spiralling flow of the fluid within the chamber.

Preferably the apparatus includes at least one further inlet for admitting a fluid, conveniently air, to the working region to prevent the pressure in the latter dropping below a predetermined level.

The further inlet may comprise a conduit of such cross sectional area as to allow fluid to bleed into the working region.

Additionally or alternatively, the further inlet may be connected to a source or fluid, for example atmosphere, through a pressure-sensitive valve.

The apparatus may with advantage include a plurality of such further inlets which may be equally circumferentially spaced around the first inlet.

Preferably the second inlet is spaced from the first inlet in the axial direction of movement of material through the working tube so that the spiralling fluid undergoes a reversal in its direction of axial movement in passing from the chamber into the working tube.

According to another aspect of the invention a method of separating the components of a mixture comprises admitting

the mixture to a first inlet, admitting a fluid under pressure to a second inlet, causing the fluid to assume a spiralling flow, causing the mixture to enter a working region into which the spiralling fluid is drawn, in the form of a vortex, and allowing the energy of the spiralling fluid to vaporise at least one of the components of the mixture, ready for the vaporised component to be separated from the remainder of the mixture.

Preferably the spiralling fluid is drawn into the working region through a throat.

The axial direction of movement of the spiralling fluid may with advantage be reversed in its passage between the second inlet and the working region.

Brief Description of the Drawings

The invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a side elevation of apparatus according to the invention;

Figure 2 is a longitudinal cross-section of the apparatus of Figure 1;

Figure 3 is a section on the line III-III of Figure 1 and;

Figure 4 is a section on the line IV-IV of Figure 1.

Detailed Description

With reference to Figures 1 and 2 the apparatus comprises an open-ended cylindrical casing 6 having at each end a respective outer, radial, annular flange 8 and 10 for attachment to an end piece 3 and an inner sub-assembly 4.

As can be seen from Figure 4, the casing 6 includes an opening 7 which communicates with an inlet pipe 9 so as to provide an inlet for a pressurised fluid.

The sub-assembly 4 includes a cylindrical working tube 12 which extends axially into the casing 6 and is screwed at its downstream end to the inner circumference of a ring 14. The ring 14 is, in turn, bolted onto the flange 10 by means of a plurality of nuts and bolts such as at 16 which extend through corresponding pairs of aligned bores in the ring 14 and flange 10. The downstream end of the tube 12 is also connected to an outlet tube 18 of the same internal diameter as the tube 12 by means of a screw-threaded connection.

The opposite end of the tube 12 includes a bevel 20 at an angle of 45° with the circumferential outer surface of the tube 12.

The end piece 3 comprises a boss 22 having a radial flange 24 bolted to the flange 8 in a similar fashion to the connection between the ring 14 and flange 10. The boss 22 includes a central internally screw threaded aperture 26 which is engaged by a corresponding screw-threaded portion 28 of an inlet tube 30 to allow adjustment of the axial position of the tube 30 relative to the tube 12.

The tube 30 includes an end connector 32 at its upstream end adapted to be connected to a supply line for the mixture to be processed and extends into the interior of the casing 6 as far as the region of the end 20 of the tube 12.

The tube 12 is spaced from the casing 6 and the end piece 3 so as to define an annular chamber 34 which communicates with the inlet pipe 9 and with the inner volume of the tube 12 through a throat defined between the downstream end of the inlet tube 30 and the bevel 20 of the tube 12.

It will be seen that the width of the throat may be varied by appropriate axial movement of the tube 30.

The pipe 9 is connected to a pump (not shown) which, in use, supplies atmospheric air to the chamber 34 at a pressure of 1.5-4 pounds per square inch and a speed of 8-10 thousand feet per minute.

Since the inlet pipe 9 admits air to the chamber 34 in a tangential direction, that air forms a spiralling flow in the chamber 34 with a mean axial component in the direction of the end 20 of the tube 12. The air thus travels along the chamber 34 until it reaches the throat formed between the bevel 20 and the tube 30.

As the air passes through the throat it accelerates, creating a region of low pressure in the region of the throat, and then forms a vortex in the tube 12, which vortex travels towards the pipe 18.

A slurry, for example coal slurry, is fed through the tube 30 towards the end 20 of the tube 12, where the zone of

low pressure tends to draw the slurry into the tube 12.

As the slurry passes through the tube 12, the energy in the vortex of air vaporises the liquid component (water) which may then be separated from the solid coal by, for example, a cyclone separator (not shown) connected to the downstream end of the pipe 18.

As the air passes through the throat at the end 20 of the tube 12, it undergoes an adiabatic expansion, causing a substantial drop in temperature. This makes the apparatus particularly useful for dewatering coal slurries, in which high temperatures may lead to a risk of explosion.

In one specific example of the apparatus, the distance between the axis of the inlet pipe 9 and the flange 10 is 4.6 inches; the external diameter of the casing 6 is 10 inches, the external diameter of the tube 12 is 6 inches; the diameter of the flanges 8, 10, 24 and of the ring 14 is 14.6 inches; and the range of axial adjustment of the tube 30 is such that the position of the downstream end of the tube 30 may be level with the apex of the end 20 of the tube 12 or may project into the tube 12 by a distance of up to 1 inch beyond the bevel 20 or may be at any intermediate position.

CLAIMS

1. Apparatus for separating the components of a mixture, comprising a first inlet to admit the mixture, a second inlet to admit a fluid under pressure, an outlet for the components of the mixture and a chamber into which the second inlet leads and which is shaped in relation to the second inlet such that the admitted fluid forms a spiralling flow, the downstream end of the first inlet communicating with a working region of the apparatus, the working region communicating with the chamber by means of a throat through which the spiralling fluid, in the form of a vortex, is drawn into the working region, in the working region the energy of the spiralling fluid vaporising at least one of the components of the mixture which passes through the outlet ready for the vaporised component to be separated.

2. Apparatus according to claim 1 in which the working region is defined within a working tube.

3. Apparatus according to claim 2 in which the working tube is cylindrical and defines the inner periphery of the chamber, the outer periphery of which is defined by an outer sleeve, the chamber thus being annular and surrounding the working region to provide a compact arrangement.

4. Apparatus according to claim 2 or claim 3 in which the throat is defined between the downstream end of the first inlet and one end of the working tube.

5. Apparatus according to claim 4 in which said one end of the working tube is bevelled so as to provide between the bevelled end of the tube and the first inlet a throat of progressively decreasing cross-sectional area in the direction of travel of the fluid as it enters the working region.

6. Apparatus according to claim 4 or claim 5 in which the first inlet comprises a cylindrical tube which is co-axial with the working tube which is of larger diameter than the tube forming the first inlet, the latter being adjustable in an axial direction to vary the effective width of the throat and, therefore, the extent of suction in the working region when the apparatus is in use.

7. Apparatus according to any of the preceding claims in which the fluid is gaseous and the second inlet enters the chamber in a tangential direction so as to promote the desired spiralling flow of the fluid within the chamber.

8. Apparatus according to any of the preceding claims in which the apparatus includes at least one further inlet for admitting a fluid to the working region to prevent the pressure in the latter dropping below a predetermined level.

9. Apparatus according to claim 8 in which the further inlet comprises a conduit of such cross sectional area as to allow fluid to bleed into the working region.

10. Apparatus according to claim 8 or claim 9 in which the further inlet is connected to a source or fluid through a pressure-sensitive valve.

11. Apparatus according to any of claims 2 to 10 in which the second inlet is spaced from the first inlet in the axial direction of movement of material through the working tube so that the spiralling fluid undergoes a reversal in its direction of axial movement in passing from the chamber into the working tube.

12. A method of separating the components of a mixture comprising admitting the mixture to a first inlet, admitting a fluid under pressure to a second inlet, causing the mixture to enter a working region into which the spiralling fluid is drawn, in the form of a vortex, and allowing the energy of the spiralling fluid to vaporise at least one of the components of the mixture, ready for the vaporised component to be separated from the remainder of the mixture.

13. A method according to claim 12 in which the spiralling fluid is drawn into the working region through a throat.

14. A method according to claim 13 in which the axial direction of movement of the spiralling fluid is reversed in its passage between the second inlet and the working region.

15. Apparatus substantially as described herein with reference to and as illustrated in the accompanying drawings.

16. Method substantially as described herein with reference to the accompanying drawings.